Records of dragonflies from Borme, Star Mountains, Papua, Indonesia (Odonata)

Vincent Kalkman

KEY WORDS
New Guinea, habitat, diversity, distribution

Entomologische Berichten 68(2): 45-52

In Borme, a village on the lower northern slopes of the Star Mountains, New Guinea, almost a week fieldwork was conducted by four affiliates of the Entomology Department of the Cenderawasih University, Abepura, Indonesia, in collaboration with two Dutch entomologists. This article presents an impression of the work and focuses on observations on dragonflies. A total of 37 species from 13 families were recorded. Information on the distribution, habitat and ecology of dragonflies in New Guinea is scarce and despite the small number of field days much new information was gathered. Comparing the results with other studies from Papua New Guinea generates the prediction that at least 70 species are present in the area.

Introduction

From a European viewpoint, the Dutch dragonfly fauna is relatively rich with its 71 species. However, real diversity is found in the tropics, where 70 species can sometimes be found in a few square kilometres. New Guinea and the adjacent Solomon islands is one of these extremely diverse places, both in habitats and insects. Over 425 species of dragonflies are known up to now. Many have never been found after their original description and have never been seen in the field by odonatologists. The dragonfly fauna is not only species rich, it has also a very high level of endemism with most of the species and 28 of the 90 genera endemic to the region. A staggering 60% of the taxa has been described by Maurits Lieftinck, mostly in a series of seven extensive papers published in period 1932 to 1949. To my knowledge Lieftinck was the only odonatologist who visited the Papuan region before 1990 and information on habitat and behaviour of the species is scarce. In the last decade there is however a renewed interest in the Papuan dragonflies, which has led to the publication of several revisions, papers on ecology and species descriptions (see Kalkman 2008 for a list of recent papers).

A long-standing wish to study the dragonflies of the Papuan region came true in July 2006 when I got the chance to participate in fieldwork conducted by the staff and students of the Cenderawasih University, Abepura, Indonesia. Most of my visit was spent on the isle of Yapen for which a separate publication on dragonflies is being prepared. The period 26-31 July was spent near the village of Borme, on the northern slopes of the Star Mountains. These mountains are part of the central mountain range running from west to east across New Guinea (figure 1). Little fieldwork on dragonflies has been conducted in this part of the central mountain chain. The only extensive collection of dragonflies was made almost seventy years earlier and about 200 km to the west, by L.J. Toxopeus during the third Archbold expedition (1938-1939). In this publication an impression is given of the fieldwork in Borme and its results.

1. Map of New Guinea, indicating the position of Borme.
1. Kaart van Nieuw-Guinea waarop de ligging van Borme is aangegeven.

Fieldwork

Fieldwork in Borme was conducted by six entomologists: Hans Huijbregts (Coleoptera) and Vincent Kalkman (Odonata), both associated with Naturalis (Leiden, The Netherlands), Icka Ramdag and Evie Warikar, both teacher at the Cenderawasih University (Abepura, Indonesia), John Keize, student at the Cenderawasih University, and Henk van Mastrigt (Lepidoptera), who initiated the fieldwork and is associated with both the Zoological Museum Amsterdam (The Netherlands) and the Cenderawasih University.

The village of Borme has a population of less than 300 people and cannot be reached by car. Two Cessna airplanes flew food, equipment (including a generator) and the team members to the village. On arrival we could see that the village lies on a mountain ridge enclosed by two steep valleys and surrounded by steep forested mountains.

2. Vincent Kalkman taking DNA-samples and drying collected dragonflies. Photo: Henk van Mastrigt.
2. Vincent Kalkman tijdens het nemen van DNA-monsters en het drogen van de verzamelde libellen.

3. Sheets and building covered with moths during collecting using light. Photo: Henk van Mastrigt.
3. Tijdens het vangen op licht waren lakens en gebouw bedekt onder de vlinders.

4. Hans Huijbregts and Henk van Mastrigt in their beetle shop. Photo: Vincent Kalkman.
4. Hans Huijbregts en Henk van Mastrigt in hun keverwinkel.

Table 1. List of localities where dragonflies were collected between 26 and 31 July 2006. All localities are in or nearby the village of Borme (04°23.745S, 140°26.020E).
Tabel 1. Lijst van locaties waar libellen werden verzameld in de periode 26 tot 31 juli 2006. Alle locaties liggen in de buurt van het dorp Borme (04°23.745S, 140°26.020E).

Loc. 1:	26, 27, 28, 29 July 2006, Borme. Small streams and ditches in village.
Loc. 2:	27 July 2006, Borme. Shaded stream a few km from village. 1000-1100 m asl.
Loc. 3:	28 July 2006, Borme. River 5-6 meter wide in degraded forest.
Loc. 4:	28 July 2006, Borme. Small stream (<1 meter).
Loc. 5:	29, 30, 31 July 2006, Borme. Small muddy brook used by pigs running through vegetation of large Pandanus trees (>5 m high) in Borme village.
Loc. 6:	29 July 2006, Borme, a few km from Borme village. Small steep stony brook in forest near loc. 7.
Loc. 7:	29 July 2006, Borme, a few km from Borme village. Natural pools, heavily degraded due to pig farming.
Loc. 8:	30 July 2006, Borme. Open boulder-strewn river.
Loc. 9:	30 July 2006, Borme. Muddy stream through shrubland.
Loc. 10:	31 July 2006, Borme. Largely unshaded brook below village.

During the six days of our stay we followed a simple routine: going out for fieldwork in the morning, returning at about 3 pm to prepare collected specimens (drying, taking DNA samples and writing) (figure 2), dinner, and then starting the generator in order to catch insects on light. Collecting insects on light started about an hour before dusk. This time of the evening proved to be the most rewarding for smaller beetles. After dusk, moths started to arrive and, somewhat later still, larger beetles such as stag beetles (Lucanidae) and longhorn beetles (Cerambycidae) made their appearance. Evenings with light rain proved to be particularly spectacular, with thousands of moths covering the sheet and buildings (figure 3). An injury prevented Hans Huijbregts from going into the field. However, starting a beetle market by paying a small sum for each beetle larger than 5 mm (not more than ten of each species) turned out to be very rewarding (figure 4). The weather during our 6-day visit was generally good, although one day was largely lost due to rain. In addition to butterflies, moths, dragonflies and beetles, some stick insects, grasshoppers, cicadas and water bugs were collected. Results on fieldwork in Papua, Indonesia and information on Papuan Entomology in general can be found on www.papua-insects.nl.

The collected dragonflies were preliminary identified based on literature and identifications were later confirmed using voucher specimens in the National Museum of Natural History Naturalis. The latter museum houses much of the material on which Maurits Lieftinck based his work and is therefore an indispensable resource for the study of Papuan dragonflies.

Results for dragonflies

A list of the localities that were sampled is given in Table 1. All localities are situated in the direct vicinity of the village as only small, slippery and steep trails were available, making it difficult to walk. Most rivers and streams sampled were at least partly impacted by the villagers, who made gardens on the hillsides. Except for some ditches in the village, standing water was limited to two natural but heavily degraded muddy pools, which were within a fenced area used for keeping pigs. All localities were between 900 and 1100 meters altitude. Table 2 gives a list of all recorded species. About 150 specimens belonging to 37 species were collected.

Notes on selected species

Argiolestes amphistylus

Previously only known from four males caught in 1939 during the 3rd Archbold Expedition at Bernhard Camp in the Snow Mountains (700-750 m) south of the Idenburg river (Lieftinck 1949). This is approximately 150-200 km west of Borme. Possibly this species is confined to the Mamberamo Foreland, as suggested by Polhemus et al. (2004). Both males were caught resting on leaves along a path.

Argiolestes sponsus

This species was common at shaded brooks. In total 13 males, three females and a pair in copula were caught. Males were found along streams resting on leaves and branches, showing almost no activity (figure 5). Females were far less abundant and probably spent their time in the forest. The pair in copula was found along a path, away from the water.

Papuagrion prothoracale and *Papuagrion occipitale*

Nearly all the specimens of *P. prothoracale* and *P. occipitale* were caught in a stand of large *Pandanus* trees. All of them were found below the canopy at a height of two meters or more. They were best found by slowly waving the net along the leaves. A small muddy brook was present beneath the trees but the specimens of *Papuagrion* were never found near this brook. The observations suggest that these species might breed in the leaf axils of *Pandanus* trees.

Papuagrion sp.

Only a single female of this species was caught. It is not one of the species of *Papuagrion* for which the female has been described; however, for six *Papuagrion* species only males are known – perhaps this specimen belongs to one of these six species. As most of the specimens of *P. prothoracale* and *P. occipitale* this specimen was found at a stand of large *Pandanus* trees and like these species it may breed in the leaf axils of those trees

Arrhenocnemis amphidactylis

The female of this species is undescribed. However, the females caught in Borme agree very well with the male of *A. amphidactylis* and are therefore believed to represent this species (pers. comm. D. Gassmann). They have the same pair of remarkable horns on the synthorax as are present in the males. Previously only known from four males collected on the third Archbold Expedition at 700 m and 1200 m altitude in the northern parts of the Snow Mountains (Lieftinck 1949).

Table 2. List of recorded species per locality. See table 1 for description of the localities.
Table 2. Lijst van waargenomen soorten per locatie. Zie tabel 1 voor een omschrijving van de locaties.

	1	2	3	4	5	6	7	8	9	10
Calopterygidae										
Neurobasis australis Selys, 1897			•			•		•		
Chlorocyphidae										
Rhinocypha tincta Rambur, 1842										•
Megapodagrionidae										
Argiolestes sponsus Lieftinck, 1956	•	•		•		•				
Argiolestes amphistylus Lieftinck, 1949		•		•						
Coenagrionidae										
Agriocnemis femina (Brauer, 1868)	•									
Papuagrion prothoracale Lieftinck, 1935					•					
Papuagrion occipitale (Selys, 1877)				•	•					
Papuagrion sp.					•					
Xiphiagrion cyanomelas Selys, 1876	•									•
Platystictidae										
Drepanosticta clavata Lieftinck, 1932	•	•		•		•				
Isostictidae										
Selysioneura phasma Lieftinck, 1932		•								
Platycnemididae										
Arrhenocnemis amphidactylis Lieftinck, 1949		•		•						
Idiocnemis obliterata Lieftinck, 1932					•	•			•	
Lochmaeocnemis malacodora Lieftinck, 1949	•	•		•	•					
Paramecocnemis stillacruoris Lieftinck, 1956						•				
Synthemistidae										
Synthemis primigenia Foerster, 1903:	•		•							
Synthemis gracilenta Lieftinck, 1935			•							
Gomphidae										
Ictinogomphus australis (Selys, 1873)										•
Aeshnidae										
Anax selysii Foerster, 1900							•			
Anax maclachlani Foerster, 1898										•
Anax sp.							•			
Corduliidae										
Procordulia leopoldi Fraser, 1932							•			
Macromiidae										
Macromia melpomene Ris, 1913						•				
Libellulidae										
Agrionoptera longitudinalis Selys, 1878	•				•					
Diplacina dioxippe Lieftinck, 1963	•							•		
Diplacina smaragdina Selys, 1878	•									•
Huonia epinephela Foerster, 1903		•		•						•
Microtrigonia sp. nov. ?	•									
Nannophlebia antiacantha Lieftinck, 1963		•								
Neurothemis stigmatizans (Fabricius, 1775)	•									
Orthetrum glaucum (Brauer, 1865)	•									
Orthetrum serapia Watson, 1984							•			
Orthetrum villosovittatum (Brauer, 1868)	•						•			
Pantala flavescens (Fabricius, 1798)							•			•
Protorthemis coronata (Brauer, 1866)	•								•	
Rhyothemis resplendens Selys, 1878							•			
Tramea eurybia Selys 1878							•			

Paramecocnemis stillacruoris

Males were fairly common at the single locality where they were found: six were collected within an hour. They were seen sitting on stones or branches lying in or along the water (figure 6). Females were not observed.

Anax selysii

The male of this species has striking colours and, in contrast to other New Guinean species of *Anax*, can easily be identified in flight. It has yellow eyes and the pale markings on the abdomen are largely green (figure 7), whereas in other *Anax* species in the region the eyes are green or blue and the abdomen has blue markings. The wings have a strong brownish tinge which is darker and more extensive than in other regional species, in which this tinge is also often confined to a part of the wings. Although less striking, also the female is easily identified by her olive green eyes and green markings on the abdomen, showing no trace of blue. The wings of the female also have a strong brownish tinge.

The species is confined to New Guinea and the five known localities (Förster 1900, Lieftinck 1942, Michalski 1995, Oppel 2005a, b) suggest that it might be absent from the lowlands and is present only at higher elevations (850-1600 m). Records thus far are from standing waters. Its presence at the strongly degraded pools at Borme makes it likely that it can breed in degraded habitats.

5. *Argiolestes sponsus* (Megapodagrionidae), Borme, New Guinea. Photo: Vincent Kalkman.

6. *Paramecocnemis stillacruoris* (Platycnemididae), Borme, New Guinea. Photo: Vincent Kalkman.

Anax sp.

One male specimen of the genus *Anax* caught at Borme does not fit with any of the six species previously recorded from New Guinea. The specimen might belong to an undescribed species. The identification of *Anax*-specimens from Southeast-Asia is often difficult and possibly several undescribed species are present in the region from Sulawesi to the Solomons. A revision of *Anax*-species occurring between mainland Asia and Australia is needed.

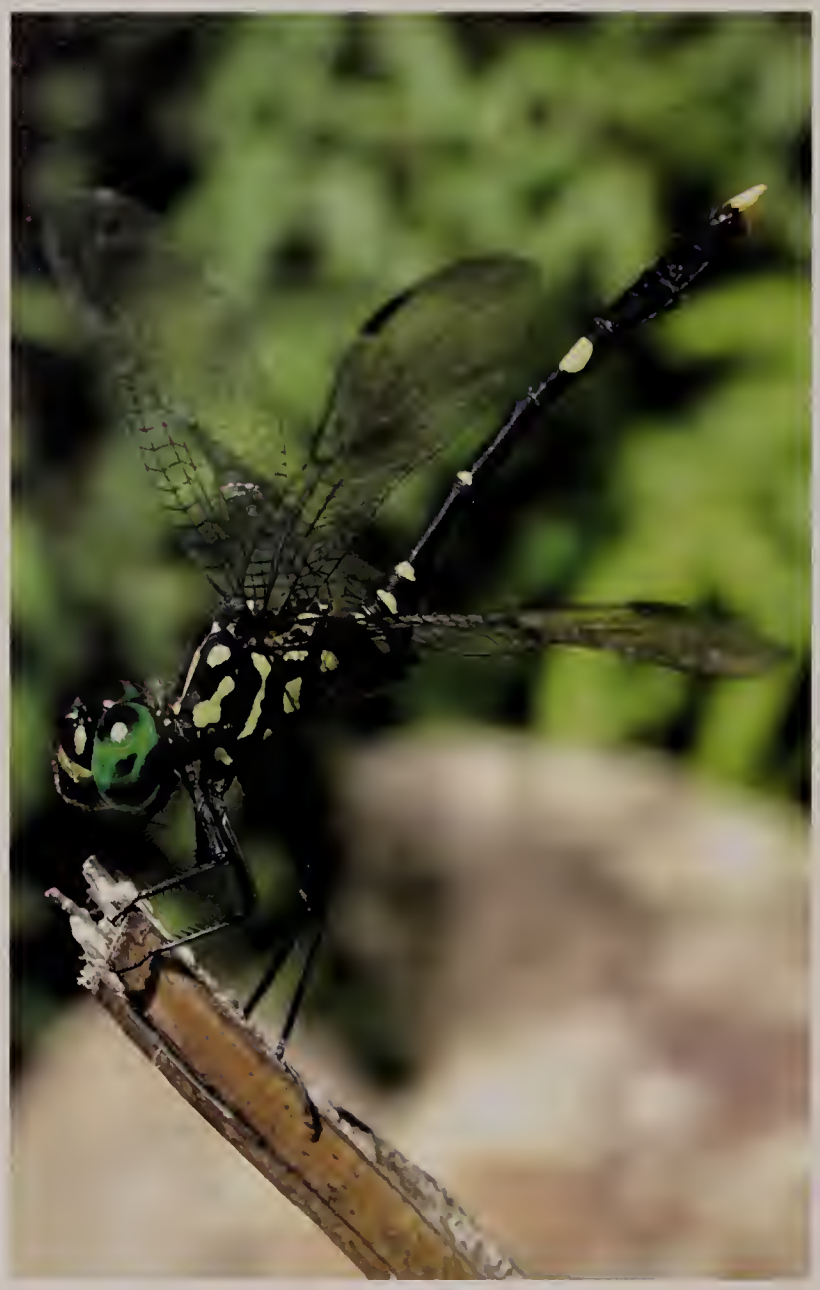
Huonia epinephela

This species was abundant along a largely unshaded brook below the village. Males were seen sitting on stones and holding territories (figure 8). Along shaded streams, only solitaire males were found.

Microtrigonia sp. nov.?

The single specimen of this taxon was caught as the prey of an *Orthetrum villosovitatum* (Libellulidae). The specimen is teneral and its abdomen is slightly damaged. It is a male and can be identified as being either a *Bironides* or a *Microtrigonia* based on its triangle in the front wing being fractured and the very long, slender and acute genital lobe. Lieftinck (1933) described three wing characters distinguishing the two genera. Based on these characters the single male from Borme belongs to *Microtrigonia*. However, these three characters correlate merely with the shape of the wing and form a feeble base to distinguish genera. The four known species of *Bironides* show a remarkable diversity in their appendages (Lieftinck 1933, 1937, 1963), none of which fits the Borme specimen. Of the three known species of *Microtrigonia*, *M. gomphoides* Lieftinck can be ruled out based on its very different appendages, and *M. marsupialis* Foerster based on its different abdominal pattern. The third species, *M. petaurina* Lieftinck, is known from a female only and was described as a new species mainly on the presence of three crossveins in the cubital field of the hind wings. The Borme

7. *Anax selysii* (Aeshnidae), Borme, New Guinea. Photo: Vincent Kalkman.



8. *Huonia epinephela* (Libellulidae), Borme, New Guinea. Photo: Vincent Kalkman.

specimen has two crossveins in the cubital field of the hind wings and it is therefore assumed that it represents either an undescribed species or the undescribed male of *M. petaurina*.

Nannophlebia antiacantha

This species was previously only known from the original description based on a male from the Star Mountains (Papua Province, Indonesia) and three males and a female from the Eastern Highlands (Papua New Guinea). Lieftinck (1963) described this species as 'A fairly large, dark green and black species with much restricted abdominal markings'. In the material from Borme the markings are yellow instead of dark green. Also, the markings on the abdomen are more extensive, this being especially true for the rings on segments three to six. Segments seven to ten are all black in the type series but one of the males from Borme (found with its exuviae) has a yellow lateral mark on segments nine and ten and an extra ring on segment seven, while the other just has a yellow lateral mark on segment nine. Also different from the type series is the yellowish colouration of the wingbase, extending to antenodal four to five in the forewing and to antenodal five to six in the hind wing in both sexes, while the wingbase is clear in the type material.

The specimens collected in Borme were compared with material in the RMNH on which Lieftinck based his description and were found to be structurally identical. The observed differences in coloration and extent of the markings are likely due to the teneral state of the specimens, with the most teneral specimen showing the most extensive markings. The yellow colouration of the wing base might also be age-related or due to regional variation.

While studying the specimens my attention was caught by the colouration of the pterostigma (wing marks), which are black above but bicoloured below, with the anterior part black and the posterior one-fifth to one-third dirty whitish. With the exception of *N. mudginberri* Watson & Theischinger I checked material of all 23 species of *Nannophlebia* in the collection of the RMNH and found this character to be present in all of them. In some older specimens the pattern tends to become obscured

9. *Protorthemis coronata* (Libellulidae), Borme, New Guinea. Photo: Vincent Kalkman

but it was always visible in the hind wings. The character is visible in the picture of *N. mudginberri* given in Theischinger & Hawking (2006). This character is not present in any other Papuan libellulid and thus facilitates easy identification of the genus.

Discussion

Most publications on New Guinean dragonflies contain mainly species descriptions, and only a few studies provide information on diversity and composition of the fauna. The best comparison for the results at Borme is offered by the recent studies of the Crater Mountain Wildlife Management Area in Papua New Guinea (Oppel 2005a, b, 2006). This site lies approximately 500 km to the east of Borme, but has approximately the same elevation and climate. During a ten-month study in this area 78 species were found, of which 61 occurred in a natural rain forest area and 37 species in a modified rain forest (the village of Herowana and surrounding gardens and plantations) (Oppel 2005b). In the natural rain forest area the species accumulation curve showed an asymptotic tendency only after ca. 100 sampling days and nine of the 61 species found during 112 days of sampling were recorded only once (Oppel 2005b). If the same species accumulation curve were valid for Borme, the total of 37 species recorded in Borme is just a small portion of the species present and the actual number of species in the direct vicinity of the village will be above 70. The comparison in Oppel (2006) between the natural and modified forest showed that the modified forest clearly holds more species that are widespread. This was also noticed during the fieldwork in Borme, with the unshaded or altered habitats in the village, holding many species widespread in New Guinea (*Huonia epinephela, Diplacina smaragdina*) or even widespread in Asia and/or Australia (e.g. *Agriocnemis femina, Neurothemis stigmatizans, Orthetrum glaucum*). These widespread species were absent from the shaded streams in the forest, where only localised and poorly known species were found. Also noted by Oppel (2005a, b) is the scarcity of Anisoptera or 'true' dragonflies in forest habitats, while they dominate open, especially standing waters in the village. The same was noted in Borme, with the shaded streams in forest dominated by Zygoptera (damselflies) and open waters in the village holding large numbers of Anisoptera. Many species of Anisoptera of tropical forest spend most of their time in the forest itself and return to the water only to deposit eggs. The low abundance of Anisoptera at shaded streams might therefore be an artefact of this behaviour. The above is nicely illustrated by comparing the species compositions of location six (forest stream) and ten (village stream). At the forest stream, two Anisoptera and six Zygoptera were seen, of which three are widespread in New Guinea and five are confined to a small area of New Guinea. At the village stream five Anisoptera were seen and two Zygoptera, all seven species being widespread on New Guinea.

Species ranges in New Guinea are often small and there is little use in comparing the fauna of Borme and the Crater Mountain Wildlife Management on the species level. There are, however, some interesting differences when looking at the genus level. Most striking is the presence of eleven species of *Drepanosticta* and eight species of *Argiolestes* in Oppel's study, while at Borme respectively one and two species of these genera were noted. A longer study at Borme would largely make up for this difference but there are reasons to assume that these differences are genuine for at least some genera. During the same trip in 2006 I caught specimens of the genus *Drepanosticta* at widely different locations (the isle of Yapen, the surrounding of Jayapura and Borme) over a wide range of heights (sea level to 1000 m). All these specimens seem to belong to one species, giving the impression that the diversity of this genus in the west of Papua is not as remarkable as in the east. Information on the distribution of New Guinean species is still too fragmented, however, to fully understand the origin of these patterns.

Acknowledgements

The participation in this expedition was made possible by the Uyttenboogaart-Eliasen Stichting. Dirk Gassmann, Matti Hämäläinen and Jan van Tol checked the identification of the Platycnemididae, Calopterygidae and Platystictidae, respectively. Jan van Tol and Graham Reels gave comments on the manuscript.

References

Förster F 1900. Odonaten aus Neu-Guinea II. Természetrajzi füzetek 23: 81-108.

Kalkman VJ 2008. Two new dragonfly species from Yapen and Biak, Papua (Irian Jaya), Indonesia (Odonata). Zoologische Mededelingen 82: 81-89.

Lieftinck MA 1933. The dragonflies (Odonata) of New Guinea and neighbouring islands. Part II. Descriptions of a new genus and species of Platycneminae (Agrionidae) and of new Libellulidae. Nova Guinea 17: 1-66.

Lieftinck MA 1937. The dragonflies (Odonata) of New Guinea and neighbouring islands. Part IV. Descriptions of new and little known species of the families Agrionidae (sens. lat.), Libellulidae and Aeshnidae (genera *Idiocnemis, Notoneura, Papuagrion, Teinobasis, Aciagrion, Bironides, Agyrtacantha, Plattycantha*, and *Oraeschna*). Nova Guinea (N.S.) 1: 1-82.

Lieftinck MA 1942. The dragonflies (Odonata) of New Guinea and neighbouring islands. Part VI. Results of the Third Archbold Expedition 1938-'39 and of the Le Roux Expedition 1939 to Netherlands New Guinea (I. Anisoptera). Treubia 18: 441-608.

Lieftinck MA 1949. The dragonflies (Odonata) of New Guinea and neighbouring islands. Part VII. Results of the Third Archbold expedition 1938-1939 and of the Le Roux Expedition 1939 to Netherlands New Guinea (II. Zygoptera). Nova Guinea (N.S.) 5: 1-271.

Lieftinck MA 1963. New species and records of Libellulidae from the Papuan region (Odonata). Nova Guinea 25: 751-780.

Michalski J 1995. New Guinea continued. Argia 7: 12-17.

Oppel S 2005a. Habitat association of an Odonata community in a lower montane rainforest in Papua New Guinea. International Journal of Odonatology 8: 243-257.

Oppel S 2005b. Odonata in the Crater Mountain Wildlife Management Area, Papua New Guinea. IDF-Report 7: 1-28.

Oppel S 2006. Comparison of two Odonata communities from a natural and a modified rainforest in Papua New Guinea. International Journal of Odonatology 9: 89-102.

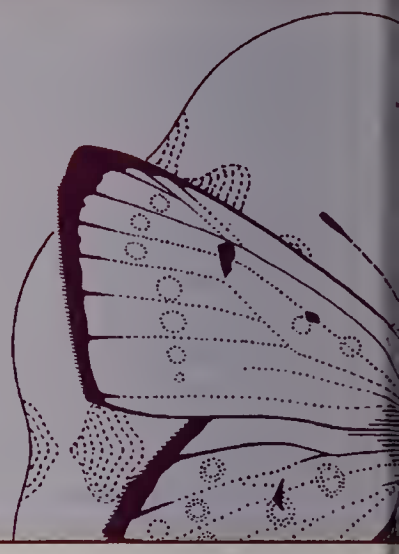
Polhemus DA, Englund AR & Allen GR 2004. Freshwater biotas of New Guinea and nearby islands: analysis of endemism, richness, and threats. Final Report Prepared For Conservation International, Washington, D.C.

Theischinger G & J Hawking 2006. The complete field guide to dragonflies of Australia. CSIRO Publishing.

Ingekomen: 30 september 2007
Geaccepteerd: 4 februari 2008

Samenvatting

Waarnemingen van libellen van Borme, Sterrengebergte, Papua, Indonesië (Odonata)
Van 26 tot 31 juli 2006 hebben vier medewerkers van de vakgroep Entomologie van de Cenderawasih University (Abepura, Indonesië), samen met twee Nederlandse entomologen, veldwerk gedaan in Borme, een dorp aan de noordrand van het Sterrengebergte in Nieuw Guinea. Het artikel geeft een kort overzicht van de uitgevoerde werkzaamheden en behandelt de waarnemingen van libellen in detail. In totaal zijn 37 soorten verdeeld over 13 families waargenomen. Informatie over verspreiding, habitat en ecologie van de libellen van Nieuw Guinea is erg schaars en ondanks het kleine aantal velddagen heeft het veldwerk veel nieuwe informatie opgeleverd. Vergelijking met een studie in een vergelijkbaar gebied in Papua Nieuw Guinea doet vermoeden dat het werkelijke aantal soorten in het gebied waarschijnlijk boven de zeventig ligt.



Vincent J. Kalkman
National Museum of Natural History Naturalis
Postbus 9517
2300 RA Leiden
kalkman@naturalis.nl